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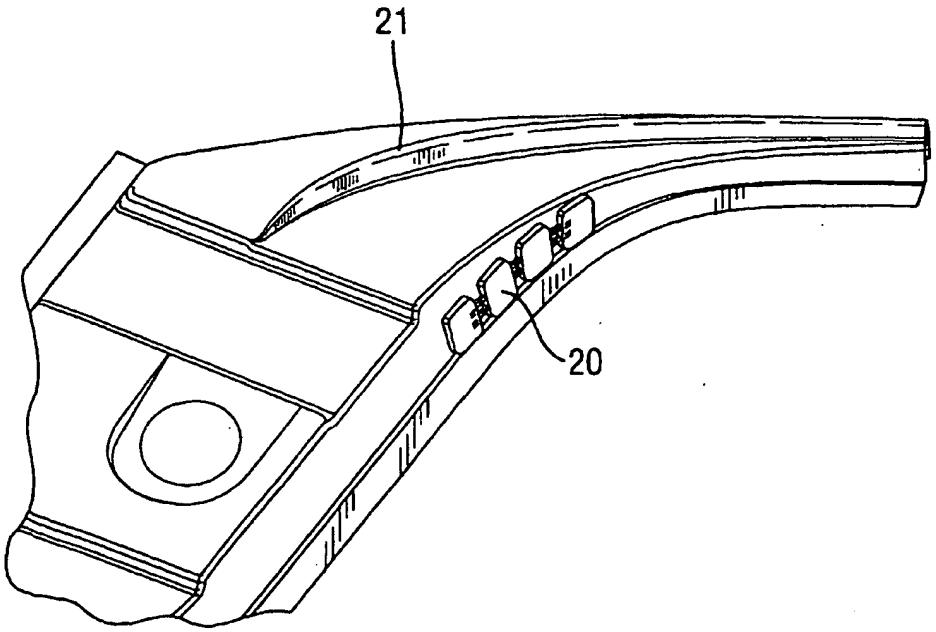
(54) Multi segment reinforcement parts

(57) A part (20) for reinforcement of hollow structures comprises a series of segments flexibly interlinked to enable the part to be adjusted to fit structures of irregular cross section and direction, the segments contain foamable material which can be activated to fill the space between the parts and the hollow structure.

FIG. 3



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Description

[0001] The present invention relates to materials useful for structural reinforcement of cavities and also as sound reducing baffles. In particular the invention relates to reinforcing materials that can be provided in hollow cross-sectional members to provide reinforcement to improve the structural integrity of vehicles, construction materials, aircraft, ships and railroad applications and/or to produce a sound deadening effect in vehicles, construction materials, aircraft and ships. The invention further provides a system whereby reinforcement and/or a sound deadening effect can be provided whilst ensuring effective provision of an anti-corrosion coating on the inner surface of the hollow cross-sectional member by the electrocoat process used in automobile construction. The electro-coat process is a process in which a metal structure is passed through a bath of anticorrosion fluid and the structure is used as an electrode whereby an anticorrosion coating is deposited from the fluid onto the vehicle structure by electrolysis. The anticorrosion coating is subsequently secured on the structure by baking in an oven.

[0002] The trends in motor vehicle, aircraft, ship and construction material design are towards lighter structures, which with vehicles, aircraft and ships leads to improved fuel consumption. At the same time safety standards and requirements are becoming more rigorous as indicated by the European Union requirements and the Euro-NCAP impact testing. The use of lighter materials such as aluminium to produce the hollow cross-sectional members that are used as vehicle sub frames has lead to the need for additional reinforcement.

[0003] There is a need for reinforcement in various positions in a vehicle structure including the sub frame and upper structure and the form of reinforcement required can vary from one location in the vehicle to another and from vehicle to vehicle. In one aspect the present invention therefore improves the strength of vehicle structures made from existing materials and enhances the safety of vehicle structures based on lighter materials.

[0004] There are four main types of application where structural reinforcement is required in vehicles. Crash protection where the prevention of vehicle body deformation is important to provide protection for the occupants. Energy absorption to enhance performance after yield. The reduction of flexing or body movement in the vehicle structure particular to improve durability and reduce stress cracking and the point mobility problems requiring the reduction of resonance by the provision of stiffening. The need for reinforcement is present irrespective of the materials that are used to produce the vehicle structure and the need varies from material to material according to the nature of the reinforcement that is being provided. There is also a need to reduce the noise created by the motion of vehicles, ships, aircraft and construction materials by providing sound deadening by blocking air paths in cavities. The materials provided by the present invention can therefore provide reinforcement, they can act as acoustic baffles or they can serve both functions.

[0005] It is known to provide longitudinal reinforcing structures within the hollow cross sections of vehicles. For example, PCT Publication WO97/43501 provides a beam, which can be mounted within the cross section to provide reinforcement along one axis in a hollow structure. The beam is provided with an expandable adhesive on two surfaces, which can be foamed upon heating to bond the beam to two opposed walls of the cross section. However, the beam will only provide significant reinforcement along the axis of the beam. In WO97/43501 the beam with foamable material on opposed surfaces is placed in the cavity and subsequently foamed under the action of heat. This will result in uneven foaming and to non-uniform foam structures since on the underside because the foam must raise the weight of the beam whereas expansion on the topside is free.

[0006] It is also known to provide foamable plastic mouldings within the hollow cross sections which can be foamed upon application of heat, such as is provided in the baking oven in the electrocoat process, to provide a foamed baffle that fills the cross-section to provide either structural reinforcement or sound adsorption. Such systems are described in European patent applications 0383498 and 0611778. The foam baffle provides sound deadening and vibration resistance. In these systems the entire insert is foamable and it is proposed that the foamable material be chosen so that it will foam during the baking process, which follows the electrocoat process typically used in vehicle manufacture to provide resistance to metal corrosion. The materials of these patents are primarily used to provide acoustic baffles and seals.

[0007] In the electro-coat process a vehicle structure is immersed in a bath of coating fluid from which an anticorrosion coating is deposited on the metal by electrolysis. The vehicle metal structure is subsequently heated to bake the coating on the metal. The electrocoat process is typically applied to complete vehicle structures in which hollow sections have been capped. Accordingly any reinforcing structures are preferably provided within hollow sections prior to the electrocoat. It is therefore important that the reinforcing structure have minimal impact on the operation and efficiency of the electrocoat process.

[0008] It has also been proposed that structural reinforcement, particularly in vehicles, may be achieved by providing a reinforcing core coated with an expandable adhesive. This structural reinforcement may be appropriately positioned in the hollow vehicle structure. The vehicle structure containing the structural reinforcement with the expandable adhesive in its unexpanded state may then be subjected to the e coat anticorrosion proc-

ess. The expandable adhesive may then be selected so that it will foam under the conditions in the bake oven of the e coat process to fill the gap between the reinforcing core and the internal surface of the hollow vehicle structure and also for a rigid bond there between.

[0009] The structural reinforcing and/or sound deadening parts that have been provided hitherto are based on a rigid core with a foamable coating thereon. It is therefore difficult with these materials to reinforce sections that contain bends or are of variable cross section. Furthermore, they are generally not suitable for the reinforcement of sections of small cross section such as some of the sections found in the A, B and C pillars of automobiles.

[0010] There is therefore a need to provide structural reinforcement and/or acoustic baffles for the hollow cross-sections of vehicles, which are easily supplied, may be readily used in sections that contain bends or are of narrow and/or variable cross section and which work well within the bounds of the electrocoat process. Where structural reinforcement is to be provided the part must provide effective reinforcement to the vehicle both during vehicle operation and as crash protection.

[0011] The present invention therefore provides a member comprising at least two interconnected segments each segment comprising a support member defining a cavity within the support member and containing a foamable material within said cavity the segments being connected in a manner that enables flexible movement of the segments relative to each other.

[0012] The preferred members comprise at least three and more preferably at least four interconnected segments.

[0013] In a preferred embodiment the cavity within the support member contains ribs which define spaces for and support the foamable material. The ribs also provide additional reinforcement and help to guide the expansion of the foamable material.

[0014] In a further embodiment of the invention the foamable material fills the spaces defined by the ribs.

[0015] In a further embodiment of the invention a small plate, preferably a circular plate is provided in the cavity which supports the foamable material within the cavity. The plate reduces the bending of the ribs during injection of the foamable material. It is also preferred that the plate is integral with the ribs so that the ribs and the plate provide a structure within the cavity which supports and directs the foamable material particularly during foaming when it can be in the form of a low viscosity liquid.

[0016] In a yet further embodiment of the invention the member is provided with clips to enable it to be attached to the surface of the structure. The location of the clips and the number of segments in the reinforcing member will depend upon the nature and shape of the structure to be reinforced. Alternatively, the part may be adhered to the structure or the structure itself may be provided with means for attachment.

[0017] In yet another embodiment of the invention at least part of the internal walls of the support member, which defines the cavity, are provided with an internally facing lip which supports the foamable material and supports and directs the material as it foams. Preferably the lip is provided on all the internal walls.

[0018] The member may also be provided with small lugs, which enable it to stand away from the interior walls of the sections of the vehicle. In this way the fastening devices previously described are not required and the area of contact between the member and the interior walls of the frame of the vehicle is minimised. The clearance between the extremity of the member and the interior walls of the frame of the vehicle is preferably wide enough to enable the liquid used in the electrocoat bath to flow between the member and the interior walls of the sections of the vehicle in sufficient quantity to enable an effective anti-corrosion coating to be deposited. On the other hand, the clearance must not be too wide since this can result in a lack of rigidity in the structure when the expandable adhesive is foamed to fill the clearance and bond the member to the interior walls of the frame of the vehicle. We prefer that the clearance be no more than 1 centimetre and is more preferably 3 to 10 millimetres. A clearance around the whole structure enables a more uniform foam structure to be obtained.

[0019] The invention can be used to provide structural reinforcement and/or sound deadening. The materials from which the member is made will be chosen according to the effect the part is to impart. In a preferred embodiment the invention provides structural reinforcement and it will now be described in relation to that embodiment.

[0020] The reinforcing member may be made from any suitable material, for example it may be made of metal or plastic and the material will be chosen according to the preferred fabrication method. This in turn is driven by economics and the complexity of the cross section to be reinforced. Reinforcing members for simple cross sections may be prepared by extrusion whilst injection moulding may be required for more complex structures. Metal members may be produced by stamping and/or forming. Where extrusion is used the members may be of metal or thermoplastics; where injection moulding is used thermoplastics are preferred. Polyamides, particularly glass filled polyamides are suitable materials due to their high strength to weight ratio. Alternatively injection moulding or die casting of metal alloys may be employed. Injection moulding is particularly preferred because this allows the segments to be moulded together with an integrally moulded, flexible, interconnecting piece to provide the desired degree of flexibility.

[0021] The member of the present invention may be of any thickness, although the invention is most useful in thin and/or narrow cross sections particularly those with bends when it will also be relatively thin. The flexible nature of the links between the segments allows the

member to be manipulated to match the contours of the section to be reinforced or the cavity wherein it is desired to provide reinforcement and/or an acoustic baffle. The preferred shape and structure of the member will depend upon where it is to be located in the vehicle structure and the function it is to perform. For example, if it is to be located in the front longitudinal section of the vehicle it will be designed for crash or impact resistance. On the other hand, it may be designed to reduce point mobility such as for example at the base of side and rear pillars. This is particularly important with high-sided vehicles where the reinforcement can reduce or prevent vehicle sway thus reducing metal fatigue. Other applications include the resistance of deformation of the rear longitudinal section, in particular to prevent upward deformation from rear impact, which can prevent the doors from being opened thus trapping the occupants. Parts of the vehicle which may be reinforced by the techniques of the present invention include roof structures, pillars, such as the A pillar, B pillar or C pillar, frame cross members and window frames particularly rear window frames.

[0022] The expandable adhesive material serves two main functions, it will expand to fill the space between the reinforcing member and the interior of the vehicle structure and it will also bond to the interior wall of the structure. Accordingly, expandable adhesive material means that the material can be activated to both expand (typically foam) and to act as an adhesive. Activation therefore enables the expandable material to expand out of the support member of the segment and bridge the gap between the reinforcing member and the hollow structure it is designed to reinforce and also to bond to the internal surface of the hollow structure. Accordingly, in order to provide reinforcement the expandable adhesive must expand at the desired temperature and be sufficiently adhesive to firmly bond the reinforcing member inside the vehicle structure. Once foamed it should be sufficiently strong that it does not contribute any weakness to the overall reinforcing effect provided.

[0023] Prior to activation, the expandable adhesive material is preferably dry and not tacky to the touch, since this facilitates shipping and handling and prevents contamination. Examples of preferred foamable materials for the production of reinforcing materials include foamable epoxy-base resins and examples of such materials are the products L5206, L5207, L5208 and L5209, which are commercially available from L & L Products of Rome Michigan USA, and the Betacore Products BC 5204, 5206, 5205 and 5208 available from Core Products, Strasbourg, France. The product should be chosen according to the rate of expansion and foam densities required. It is further preferred that it expand at the temperatures experienced in the electrocoat baking oven, typically 130°C to 200°C, preferably 130°C to 150°C. If the invention is to be used to provide acoustic baffles the expandable material may be a thermoplastic such as copolymer of ethylene and vinyl acetate or an ethylene acrylate copolymer.

[0024] It is preferred that the reinforcing member is located within the hollow member that it is designed to reinforce in a manner that provides a clearance between the external surface of the member and the internal surface of the hollow member. This allows for the passage of the electrocoat fluid between the member and the internal surface and also enables a uniform expansion of the foam around the member to provide more uniform reinforcement. Accordingly in a preferred process for providing reinforcement within hollow structures such as a vehicle frame, moulded reinforcing members containing the foamable adhesive are installed during assembly of the vehicle frame prior to the frame being subjected to the e coat process.

[0025] Means are preferably provided to position the moulded reinforcing members away from the surface so that the anticorrosion fluid can reach all parts of the surface. These means may be clips or other fastenings which hold the member away from the surface. The clips may be formed on the surfaces or on the moulded reinforcing member itself or both. Alternatively locating lugs may be moulded into the reinforcing member so that the reinforcing member sits within the vehicle structure leaving a space between the member and the interior walls of the cavity to be reinforced, in this way there is no need for fastening or bonding means to attach the member to the interior walls. The assembled structure may then be subjected to the electrocoat process in which it is passed through a bath of coating material and a corrosion resistant coating is deposited onto the structure by electrolysis. The vehicle structure is then dried in an oven to provide the final anticorrosion coating. The expandable adhesive is preferably chosen so that it is activated by the drying conditions used in the oven employed to bake the coating on the electrocoat process. In this way the expandable material will expand under the drying conditions to provide a foam that fills the space between the member and the interior walls to produce a bond between the reinforcing member and the interior wall. Typically the coated structure is dried at around 165°C for about 20 minutes and accordingly the adhesive should expand under these conditions. The industry is however looking to use lower drying temperatures and shorter drying times and this may influence the choice of expandable adhesive materials.

[0026] The techniques of the present invention may be used for the reinforcement of any construction that is based on a hollow frame structure. They may for instance be used in the construction industry, in boats, in aircraft, and in railroad applications.

[0027] They are however particularly useful to provide reinforcement in automobiles including cars, trucks, caravans and the like. The techniques are particularly useful in the current trend towards using lighter and sometimes weaker materials in the production of automobile sub frames where there is a greater need for reinforcement to compensate for the reduction in strength of the

basic material and yet satisfy the safety requirements. This is particularly the case with the use of aluminium for the production of automobiles. The invention readily enables reinforcement to be provided in narrow or non-uniform or non-linear hollow sections which has hitherto been difficult to achieve.

[0028] The present invention is illustrated by reference to the accompanying drawings in which Figure 1 shows a part consisting of three interconnected segments without any expandable material present to illustrate the structure of the segments.

[0029] Figure 2 shows a four segment part similar to Figure 1 but with the expandable material being present.

[0030] Figure 3 shows a part according to the present invention attached to the interior surface of a hollow section of the A pillar of an automobile prior to foaming of the expandable material.

[0031] Figure 4 shows a part according to the present invention attached to the interior surface of a hollow section of the B pillar of an automobile prior to expansion of the expandable material.

[0032] Figure 1 shows a part according to the present invention made by injection moulding of glass filled nylon consisting of three segments (1), (2) and (3) linked by flexible interconnecting members (4) and (5). Each segment consists of a rectangular member defining a space (6), (7) and (8) ribs (9) are formed extending into the space defined by the rectangular members, the ribs are integrally moulded with discs (10), (11) and (12). The part illustrated in Figure 1 also contains two integrally moulded clips (13) and (14) which can be used to attach the part to the surface of the structure that is to be reinforced. The clips are designed to hold the part away from the surface of the structure.

[0033] Figure 2 shows a four segment part similar to Figure 1 with an additional segment (15). The foamable material (16), (17) (18) and (19) present in the spaces provided by the segments.

[0034] Figure 3 shows an unfoamed four segment part (20) similar to the part of Figure 2, mounted within the A pillar (19) of a vehicle and Figure 4 shows two such four segment parts (20) mounted in a front longitudinal section (22) of a vehicle. Figure 4 shows how the compact nature of the part enables it to be mounted in a narrow gap in the vehicle structure and it also shows how the flexible nature of the interconnecting elements enables the part to be manoeuvred to match the contoured profile of the vehicle structure.

[0035] The vehicle section with the part of this invention attached thereto may then be assembled into the vehicle body. The assembled body may then be subjected to the e coat process and finally baked. Accordingly providing the nature of the foamable material is selected so that it will foam during the baking step it will expand to fill the cavity and provide the desired structural reinforcement and/or acoustic baffle.

[0036] The invention therefore provides a convenient and flexible technique for the provision of structural reinforcement and/or noise abatement in hollow cross sections that are too small for the application of pre-existing techniques or are of variable and/or non-straight cross section.

Claims

1. A member comprising at least two interconnected segments each segment comprising a support member defining a cavity within the support member and containing a foamable material within said cavity the segments being connected in a manner that enables flexible movement of the segments relative to each other.

2. A member according to Claim 1, wherein the cavity within the support member contains ribs which define spaces for and support of the foamable material.

3. A member according to Claim 2, in which the foamable material fills the spaces defined by the ribs.

4. A member according to any of the preceding Claims, in which a small plate is provided in the cavity which supports the foamable material within the cavity.

5. A member according to Claim 4, in which the plate is integral with the ribs so that the ribs and the plate provide a structure within the cavity which supports the foamable material and directs the foamable material during foaming.

6. A member according to any of the preceding Claims, provided with clips to enable it to be attached to the surface of the structure.

7. A member according to any of the preceding Claims in which at least part of the internal walls of the support member, which define the cavity, are provided with an internally facing lip which supports the foamable material and supports and directs the material as it foams.

8. A process wherein a reinforcing member according to any of Claims 1 to 7, is located within a hollow structure in a manner that provides a clearance between the external surface of the member and the internal surface of the hollow structure and the structure is then subject to the electrocoat process.

9. A process according to Claim 8, in which an assembled structure is passed through a bath of coating material and a coating is deposited onto the surface of the hollow structure, the structure is then dried in an oven to provide the final coating and the foama-

ble material is chosen so that it is activated by the drying conditions used in the oven so that it expands under the oven conditions to provide a foam that fills the space between the member and the interior walls.

10. A process according to Claim 9 in which the coating material is a corrosion resistant coating.

FIG. 1

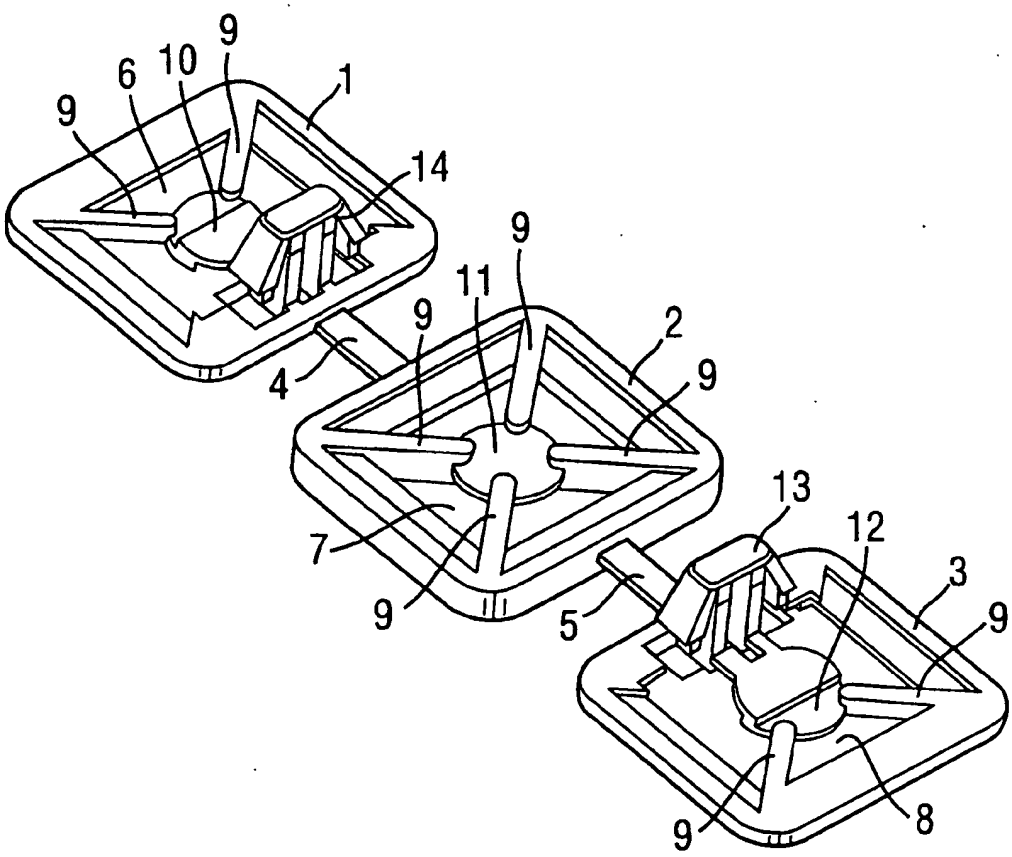

FIG. 2

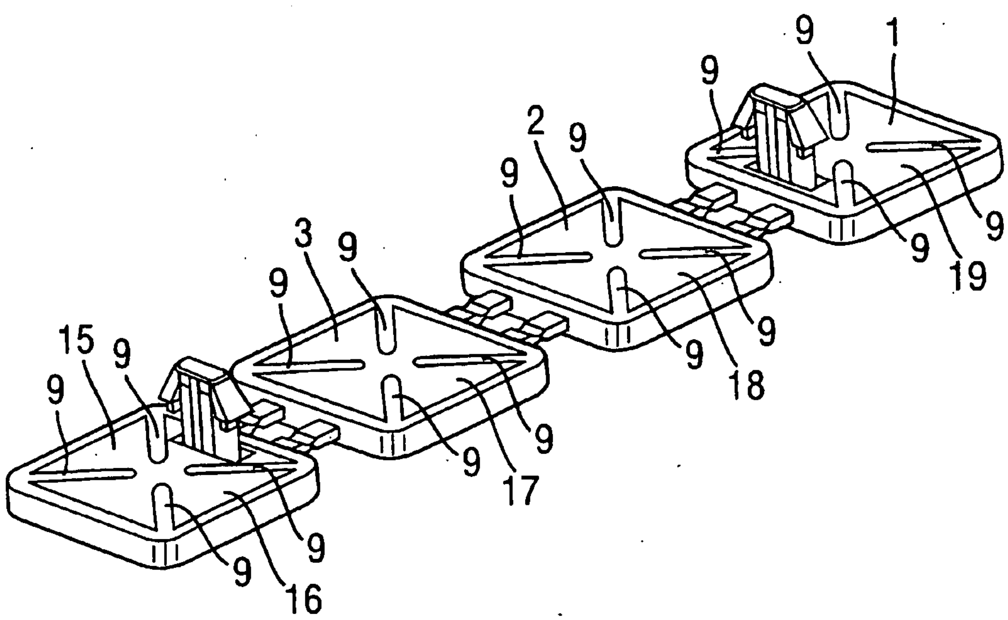

FIG. 3

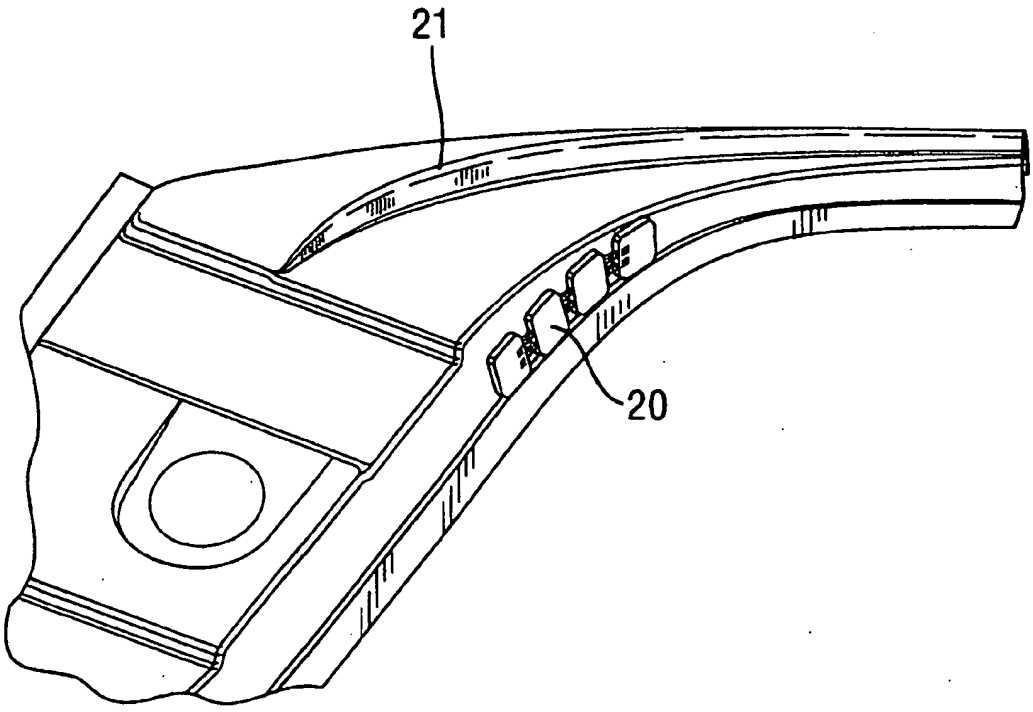

FIG. 4